AECV83-R1

Chemical Residues in Fish Tissues in Alberta

1. Wabamun Lake, Lake Newell, McGregor Lake, Beaver River, Battle River

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CHEMICAL RESIDUES IN FISH TISSUES IN ALBERTA

1. Wabamun Lake, Lake Newell, McGregor Lake, Beaver River, Battle River

ALBERTA ENVIRONMENTAL CENTRE
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Abstract

The purpose of this study was to describe the concentrations of pesticides and PCB's in fish collected during 1981 from five water systems in Alberta (Wabamun Lake, Lake Newell, McGregor Lake, Beaver River, Battle River). Approximately 190 fish, consisting of game, commercial and forage species such as walleye, pike and suckers were collected. Determinations were completed for a total of 45 compounds, including most pesticides commonly used in Alberta. Based on these collections, it can be concluded that:

1) Only PCB's, hexachlorobenzene, DDE, DDT, α-BHC, heptachlor epoxide, chlordane, oxychlordane and dieldrin can be consistently detected in muscle and fat tissues.

2) The concentrations of these substances are low and pose no threat to fish consumers.

3) Since the use of most chlorinated pesticides and PCB's is decreasing, residues in fish will also decrease.

4) There is no need for routine monitoring of pesticide and PCB residues in the five water systems. However, analysis should be reconducted in ~ 5 years to ensure that levels have remained low.

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1. INTRODUCTION

Recent increases in the production, use and discharge of organic and inorganic chemicals have resulted in the widespread and occasionally significant adulteration of fish tissues in Canada. Some of these compounds are highly toxic and have been implicated in a decrease in the productivity of fish populations and in the induction of neoplasia and other disorders in humans. Consequently, chemical analysis of fish tissues has become a common feature of many environmentally-related programs in Canada.

The Alberta Environmental Centre began analysis of chemical residues in fish tissues during 1980 in response to a request from Energy and Natural Resources (Fish and Wildlife Division). Samples have been collected from a considerable number of lakes and rivers in Alberta (Table 1). The majority of these systems either maintain an important fishery or are sites of known/suspected contamination. During the initial stage of the project, analysis was restricted to pesticides, halogenated biphenyls, and mercury. It is anticipated that subsequent analysis will include high molecular weight organic compounds that are commonly produced or associated with the petrochemical industry and the oil and gas industry.

The purpose of this report is to present chemical residue data for fish collected from five waterways, including Wabamun Lake, Lake Newell, McGregor Lake, the Beaver River and the Battle River [Figure 1]. It is concluded that fish from these areas do not contain significantly high chemical residues in their tissues. Consequently, there is no need to carry out routine monitoring of tissues at these sites.

Table 1. List of collection sites and target species of fish that have been analyzed by the Alberta Environmental Centre.

River/Lake	Location	Target Species
St. Mary's River	Lethbridge	pike, walleye, goldeye
Oldman River	Lethbridge	pike, walleye, goldeye
Oldman River	Crowsnest	salmonids, mountain whitefish
South Saskatchewan	Medicine Hat	pike, walleye, sauger, goldeye
Bow	Sprague Dam Bearspaw Dam	salmonids whitefish
Bow	Calgary	rainbow trout, whitefish
Bow	Bassano (below dam)	pike, walleye
Red Deer	Red Deer	goldeye, walleye, sauger
North Saskatchewan	Edmonton	pike, walleye, sauger, goldeye
North Saskatchewan	Duvernay	pike, walleye, sauger, goldeye
North Saskatchewan	Saskatchewan Border	pike, walleye, sauger, goldeye
Battle River	Forestburg	pike, walleye,
Wabamun Lake	Wabamun	pike
Beaver River		pike, walleye
Athabasca	Hinton Athabasca	pike, walleye
Peace	Dunvegan	pike, walleye
Wapiti	Grande Prairie	pike, walleye
Lake Newell		lake whitefish
McGregor Lake		lake whitefish, pike

Figure 1. Map of Alberta showing location of study area.

2. METHODS

2.1 Wabamun Lake

Wabamun Lake (Lat. 53°33'N, Long. 114°36'W) was selected for study because of the presence of two power plants (Sunwapta, Wabamun) along its shore [Figure 2]. Such plants have been known to accidentally discharge PCB-containing wastes into surface waters in other parts of Canada, although there was no evidence to indicate that this had occurred at Wabamun Lake. The lake, with a maximum length and width of 19.5 and 9.5 km respectively, has a surface area of approximately 9065 hectares and a maximum depth of 11.5 m. The lake supports a substantial sport and commercial fishery for lake whitefish, northern pike and yellow perch, due in part to its proximity (70 km) from the City of Edmonton.

One collection of northern pike, lake whitefish and white sucker was made on 26-27 May 1981. The samples were taken by gill net (length 120 m; mesh size 2.5, 7.5, 10 cm) at one site located 2 km east of Fallis Point [Figure 2]. The nets were lifted after approximately 20 h, and the fish immediately put on ice. The samples were then transported to the laboratory where they were frozen at -20°C within 4 h of collection.

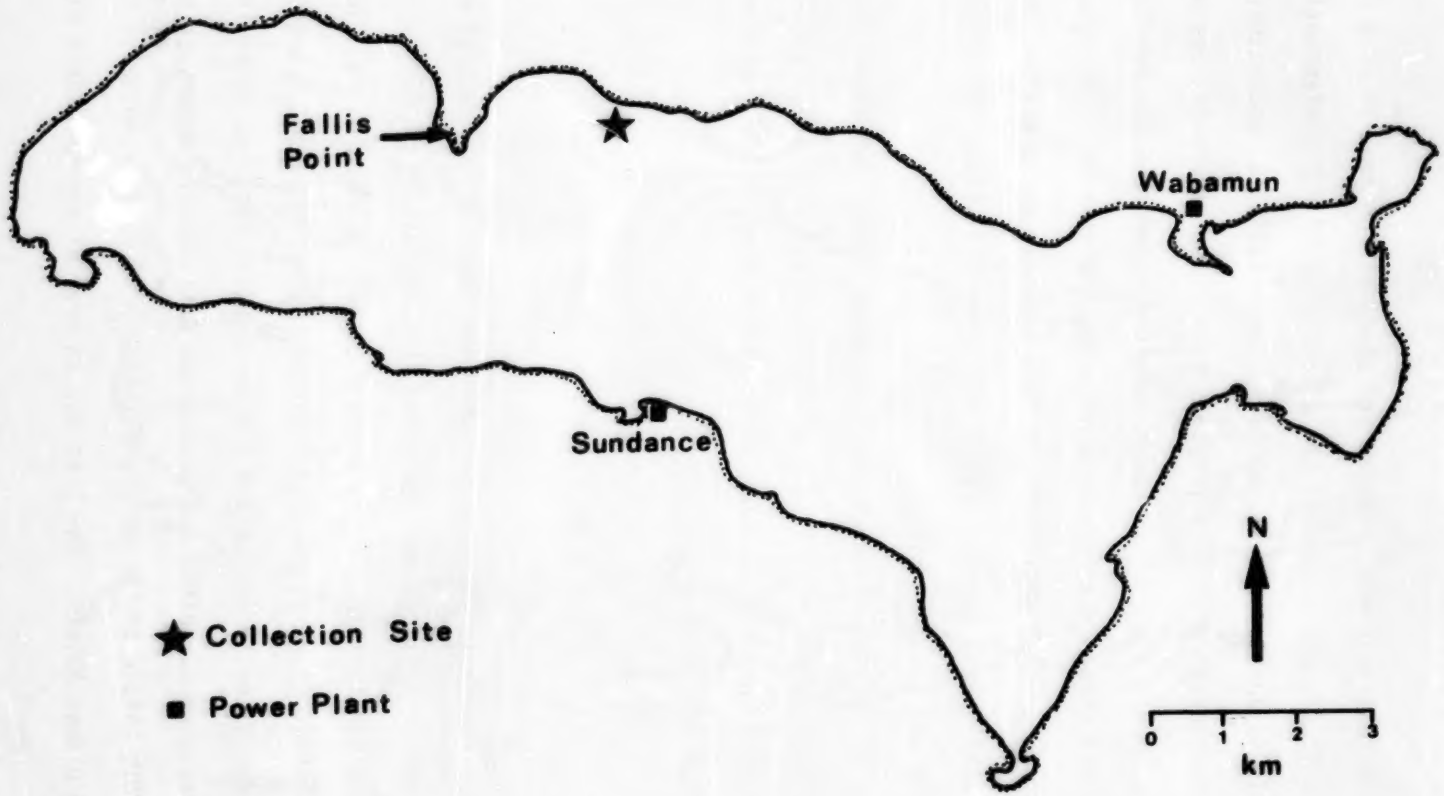

Figure 2. Wabamun Lake showing collection site.

2.2 Lake Newell (Reservoir)

This reservoir was selected for study at the request of a Public Health Officer, who suspected the possibility of PCB contamination in fish. It is located at Lat. 50°26'N; Long. 111°57'W, approximately 165 km southeast of Calgary [Figures 1,3]. The reservoir, measuring 15 km in length and 7 km in width receives water from the Bow River at Bassano and then discharges back into the Bow near Hays, Alberta. The lake has an area of approximately 7000 hectares and a maximum depth of 14 m. Lake Newell supports sport and commercial fisheries for lake whitefish and northern pike.

One collection was made on 23 November 1981. Two nets (length, 15 m each; extended mesh size 9-14 cm) were set near shore overnight [Figure 3]. The fish were put on ice and frozen at -20°C within 5 h of collection.

2.3 McGregor Lake (Reservoir)

This reservoir was also selected for study at the request of a Public Health Officer, who suspected the possibility of PCB contamination in fish. It is located at Lat. 50°30'N; Long. 112°52'W, approximately 95 km southeast of Calgary [Figures 1,4]. McGregor Lake measuring 33 km in length and 3.5 km in width receives water from the Bow River near Carseland and discharges into Travers Reservior and from there into Little Bow River and Little Bow Lake and eventually into the Bow and Oldman Rivers. The lake has an area of approximately 4176

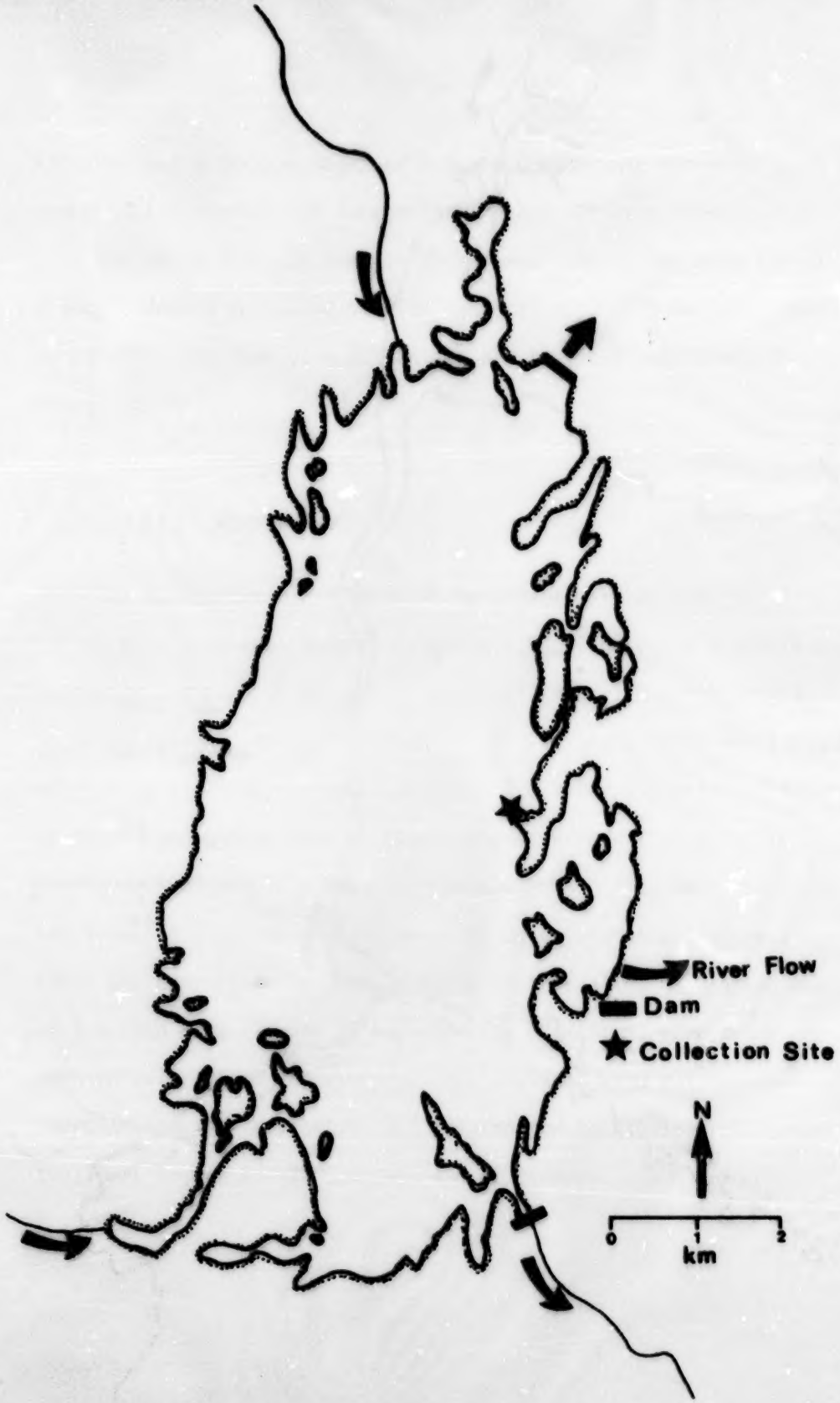

Figure 3. Lake Newell showing collection site.

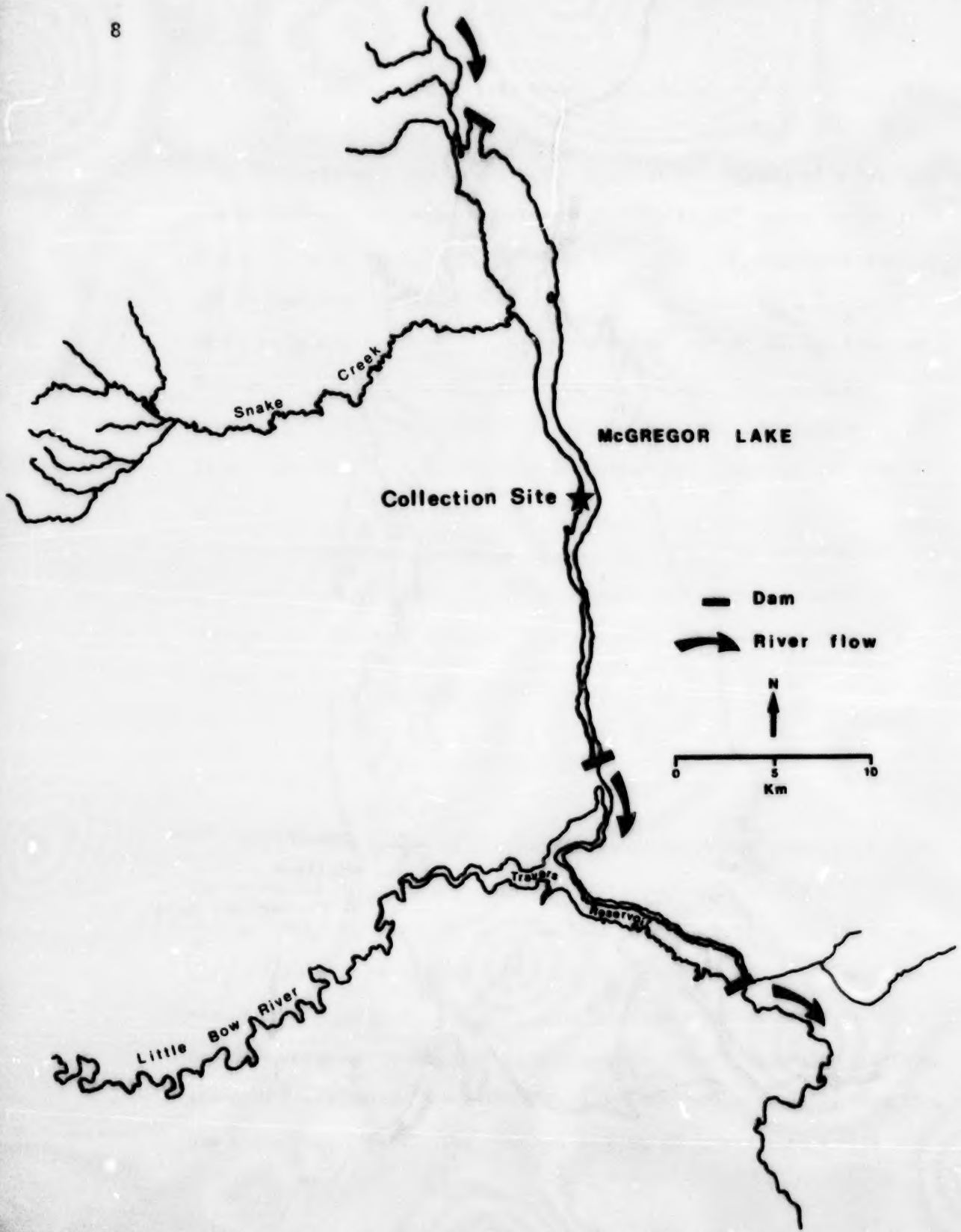

Figure 4. McGregor Lake showing collection site.

hectares and a maximum depth of 9 m. McGregor Lake supports sport and commercial fisheries for lake whitefish and northern pike.

One collection was made on 20 November 1981. Two nets (length, 15 & 30m; extended mesh size 9-14 cm respectively) were set near shore overnight. The fish were put on ice and frozen at -20°C within 5 hours of collection.

2.4 Beaver River

The Beaver River originates from Beaver Lake at Lat. 54°43'N; Long. 111°50'W in northeast Alberta [Figures 1,5]. The river flows in a generally eastward direction to its confluence with the Churchill River in Saskatchewan. It has a length of ~450 km and a total daily discharge of ~1-612m^3/sec, depending on season. The river was selected for study to obtain background data on chemical residues in fish prior to development of the Cold Lake oil sands plants. Fish were collected from one location situated at Lat. 54°23'N; Long. 110°45'W [Figure 5]. The river was approximately 30 m in width at this site, with a maximum depth of 2 m. Two nets (length 28 m, mesh size 2.5-10 cm) were set perpendicular to the shore for 15 h. The fish were put on ice immediately after collection and transported to the laboratory where they were frozen at -20°C within 4 h of capture.

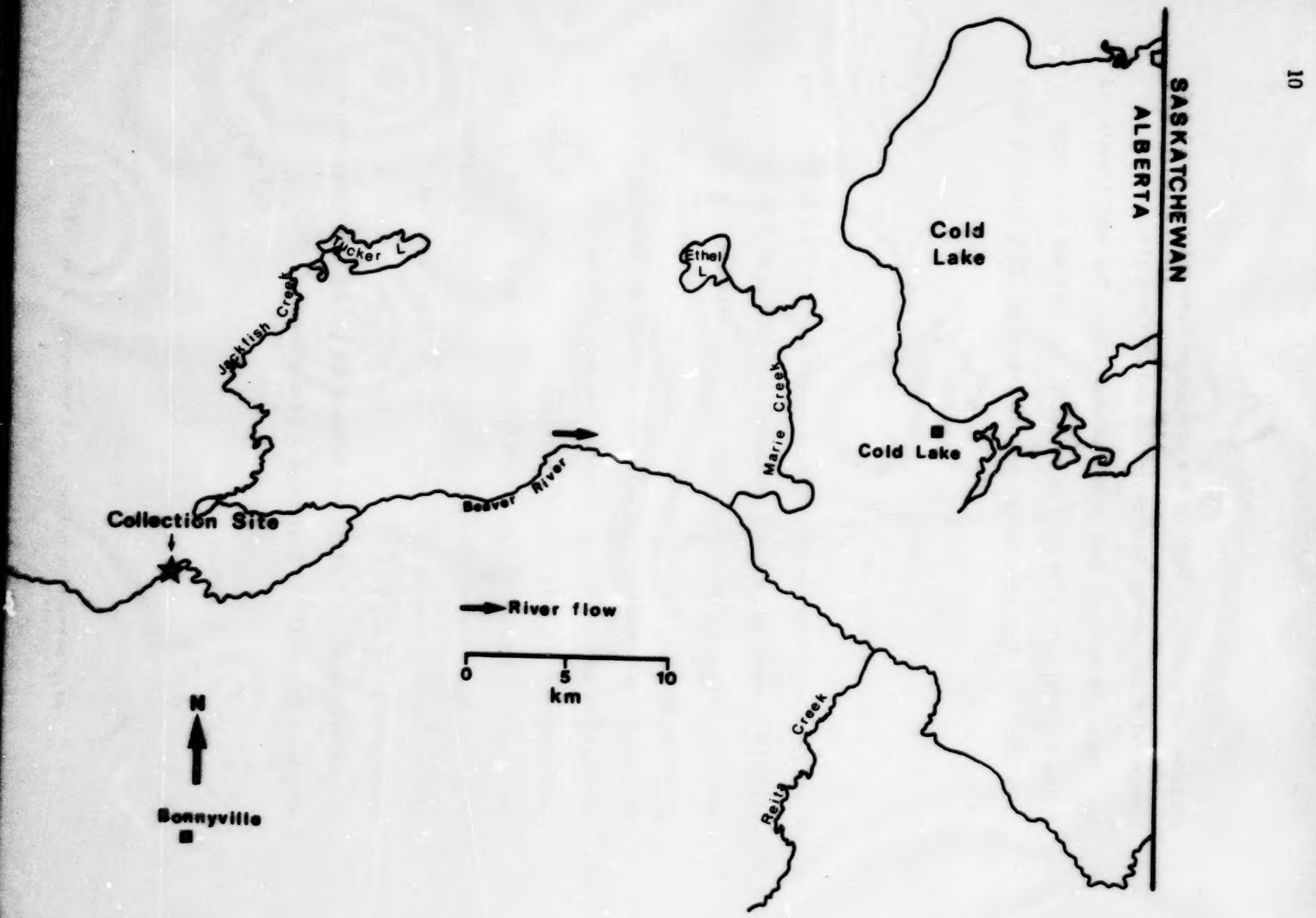

Figure 5. Beaver River showing collection site.

2.5 Battle River

The Battle River originates from Battle Lake at Lat. 53°58'N; Long. 114°11'W [Figures 1,6]. The river flows in a generally eastward direction to its confluence with the North Saskatchewan River at North Battleford, Saskatchewan. It has a total daily discharge of <1-245m^3/sec, depending on season, and a length of 600 km. Fish were collected from the Alberta Power Reservoir (Lat 52°29'N; Long 112°9'N) approximately 110 km east of Red Deer [Figure 6]. This site was selected because of the possibility of PCB contamination from the local power plant. The reservoir was 0.5 km wide at this point with a maximum depth of ~ 5 m. Three nets (length 28-90 m, mesh size 2.5-10 cm) were set perpendicular from shore on 7 July 1981 and 23 July 1981. The sets were for 16-17 h and the fish were immediately placed on ice, followed by transportation to the laboratory where they were frozen at -20°C within 3.5 h of collection.

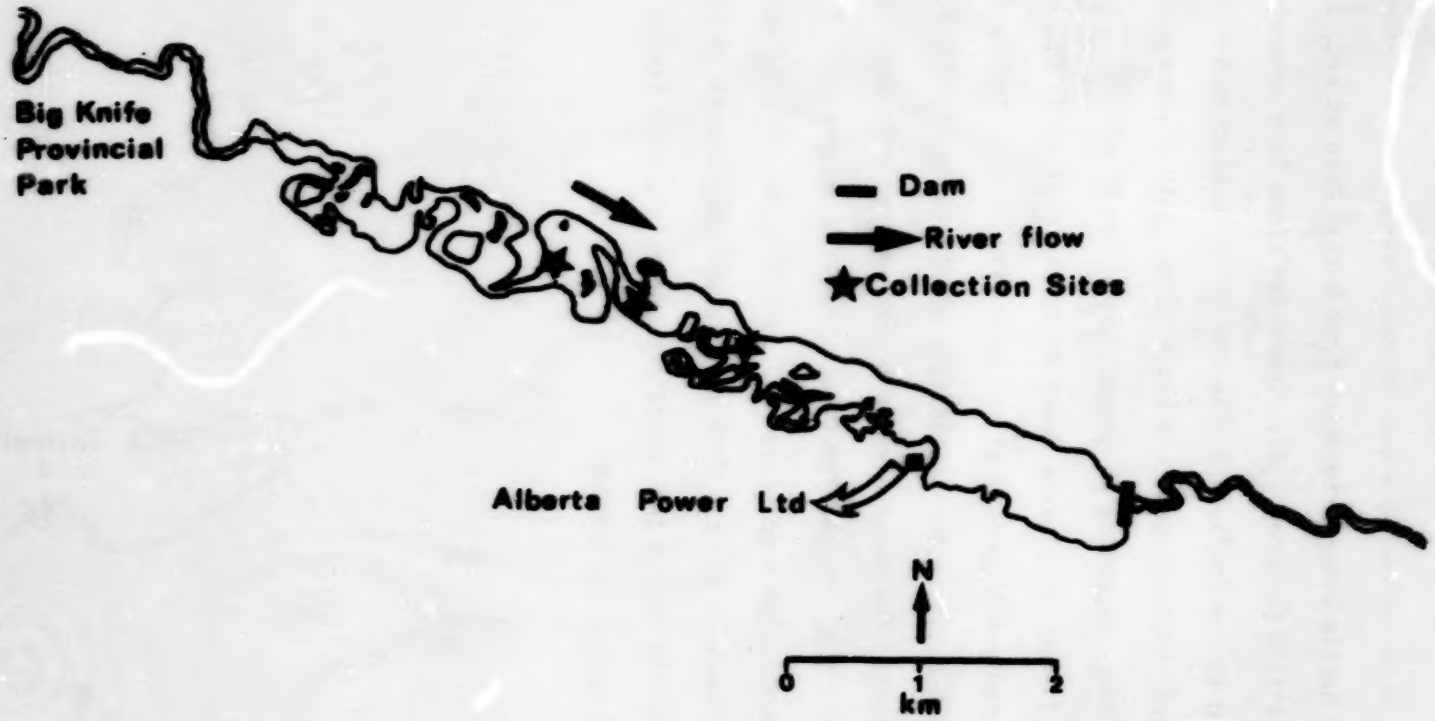

Figure 6. Battle River showing collection sites.

3. CHEMICAL ANALYSIS

One sample of muscle and one of intestinal fat was collected from each fish for chemical analysis. Muscle (approx. 250 g wet weight), including both hypaxial and epaxial tissues, was obtained using a stainless steel filleting knife and then wrapped in aluminum foil. Approximately 5 g wet weight of intestinal fat was also obtained using a stainless steel surgical knife and wrapped in foil.

The analytical method used to determine pesticide and PCB residues is given below:

Muscle:

1. 25 g of the muscle (without skin, scale and bone) was weighed into a 250 ml beaker, and 100 ml of distilled acetonitrile added.
2. Using a Polytron grinder, the muscle was ground in the solvent and then filtered in vacuum.
3. The filtrate was transferred to a 1-litre separatory funnel with 150 ml of petroleum ether. 600 ml of petroleum ether that was washed with distilled water and about 5 g of NaCl were added to the separatory funnel and shaken well.
4. The separated petroleum ether layer was dried by passing it through a pad of anhydrous sodium sulfate, and the filtrate evaporated to near-dryness. The moist residue was reconstituted in a minimum amount of petroleum ether and subjected to column chromatography.
5. A chromatography column with 50 g of Florisil containing 5% water was prepared and the concentrate was applied onto the

column. 220 ml of petroleum ether was poured onto the column and the "Petroleum Ether Fraction" was eluted. This fraction contains very non-polar compounds such as HCB, DDE, DDT, and PCB's. Then 275 ml of petroleum ether containing 25% methylene chloride was poured in and the Fraction II was eluted. This fraction contains slightly polar compounds such as α, β, γ-BHC, HE, Dieldrin, Endrin, DDD.

6. Each fraction was evaporated to near-dryness and reconstituted with a small volume of hexanes (eg. 5-10 ml) and a small portion (eg. 5 μl) of this solution was injected to a gas chromatography with an electron capture detector. A gas chromatogram thus obtained was compared to the standard pesticide gas chromatogram run along with the sample and by comparing the peak height of each pesticide, the quantities of pesticide in the sample were calculated and expressed in ppm.

Fat:

1. One gram of fat was weighed out and ground in a mortar with 25 g of Florisil containing 5% water and some anhydrous sodium sulfate.
2. A chromatography column was first prepared with 25 g of Florisil containing 5% water, then the above sample with Florisil was added on top of it.
3. The petroleum fraction I was obtained by eluting with 250 ml of petroleum ether and the fraction II obtained by eluting with 275 ml of petroleum ether containing 25% methylene chloride.

4. Detection and quantification of the pesticide by gas chromatogram is the same as the muscle samples.

Precision and accuracy:

1. Detection limit (based on 25g samples)
   - organochlorines, 0.001 ppm
   - PCB's, 0.02 ppm (without perchlorination)
     0.002 ppm (with perchlorination)
2. Recoveries from fortified fish muscle
   - organochlorines and PCB's, >80%
3. Accuracy:

Concentration of PCB's/organochlorine (mg/kg)	Limit of accuracy
1.0	± 10%
0.1	± 20%
0.01	± 50%
0.001	±100%

(according to Gunther, 1970)

4. Reproducibility (Precision):
   - ±10%

4. RESULTS

4.1 Wabamun Lake

Of the 45 compounds listed in Table 2, only eight were found in fish from Wabamun Lake (Table 3, Appendix I). PCB's occurred in the muscle tissue of all species, reaching a maximum of 0.030 mg/kg in northern pike. This value is considerably less than the maximum standard for human consumption (2 mg/kg) set by Health and Welfare Canada. PCB's residues were lower in the other species (white sucker and lake whitefish) reaching 0.010 and 0.007 mg/kg respectively. Six pesticides (HCB, α-BHC, DDE, DDD, chlordane, heptachlorepoxide) occurred in the samples but always at low concentrations.

Fat samples contained substantially higher residues than muscle tissue. This is due to the lipophilic nature of chlorinated compounds and has been recorded in essentially all chemical residue studies conducted throughout the world. PCB levels in the fat of northern pike ranged from ND to 1.07 mg/kg. The latter concentration was substantially greater than the maximum values (0.010 mg kg^{-1}) recorded for lake whitefish and white sucker. DDE and α-BHC were the prevalent compounds in the fish.

Table 2. List of organic compounds determined in this study.

Chlorinated Compounds (detection unit 0.0005 ppm)	Organo-phosphate Pesticides (0.05 ppm)	Phenoxy Pesticides (0.05 ppm)
HCB (hexachlorobenzene)	Parathion	MCPA (metachlorophenoxy acetic acid)
γ, β, α HCH (hexachlorocyclohexane, or BHC)	Diazinon	2, 4-D
Heptachlor	Sumithion	2, 4, 5-T
Heptachlor epoxide	Malathion	Picloram
Chlordane (us)	Ethion	MCPB (metachlorophenoxy butyric acid)
Oxychlordane	Dioxythion	Silvex
Aldrin	EPN (O-ethyl, O-4-nitro-phenyl phenyl phosphono-thiolate)	Dicamba
Dieldrin		Pentachlorophenol
RP^{1}DDT		
p,p^1-DDE, p,p^1-DDD	Dursban	
Dicosol		Other (0.05ppm)
Aroclor 1254, 1260, 1242		Tedion
Polybrominated Biphenyls		Daconil
Mirex		
Pentachlorobenzene		
Toxaphene		
Methoxychlor		
Perthane		
Telodrine		
PCNB (Pentachloronitrobenzene)		
TCNB (Tetrachloronitrobenzene)		
Endosulfan		
Thiodan I		
Endrin		

Table 3. Range in concentration (mg/kg wet weight) of pesticides and PCB's in fish from Wabamun Lake, ND <0.0005 mg/kg

MUSCLE

Species	Sample Size	Fish Weight (kg) Range (Average)	HCB	∝-BHC	DDE	DDD	Chlordane	PCB's
Northern Pike	20	0.31-2.48 (0.87)	ND-0.001	ND-0.003	ND-0.007	ND-0.001	ND-0.001	ND-0.030
Lake Whitefish	13	0.38-0.94 (0.68)	ND-0.001	ND-0.006	ND-0.006	ND-0.003	ND	ND-0.007
White Sucker	17	0.67-1.60 (1.12)	ND-0.001	0.001-0.005	ND-0.002	ND	ND	ND-0.010

FAT

Northern Pike	20	0.31-2.48 (0.87)	ND-0.025	0.008-0.174	0.010-0.243	ND	ND-0.034	ND-1.07
Lake Whitefish	13	0.38-0.94 (0.68)	0.003-0.009	0.030-0.052	0.030-0.039	ND	ND	ND-0.010
White Sucker	17	0.67-1.60 (1.12)	0.004-0.019	0.051-0.142	0.002-0.052	ND	ND	ND-0.010

4.2 Lake Newell

The only species collected, lake whitefish, contained detectable residues of two compounds in their muscle tissue. DDE was the more common of the two, reaching a maximum of 0.003 mg/kg, whereas the peak value for ∝-BHC was 0.001 mg/kg (Table 4; Appendix II).

Fat samples from the whitefish contained PCB's DDE, ∝-BHC, HCB, heptachlorepoxide, dieldrin and chlordane. Of these, PCB's occurred in greatest concentrations (up to 0.94 mg/kg), followed by DDE (0.132 mg/kg) and ∝-BHC (0.094 mg/kg).

4.3 McGregor Lake

Lake whitefish contained detectable concentrations of HCB, ∝-BHC, DDE, DDD, heptachlorepoxide and dieldrin in their muscle (Table 4, Appendix III). Although peak levels ranged from 0.001 to 0.009 mg/kg, substantially greater residues (0.022-0.151 mg/kg) were recorded for the fat samples. In addition, PCB's peaked at 0.75 mg/kg in fat despite their absence from the muscle tissue.

The concentrations of pesticides and PCB's in northern pike were generally similar to those outlined for lake whitefish (Table 4, Appendix III). The only appreciable differences were the fat samples, where DDE and PCB's occurred in relatively high concentrations (0.34 and 3.78 mg/kg respectively).

Table 4. Range in concentration (mg/kg wet weight) of pesticides and PCB's in fish from Lake Newell, McGregor Lake and the Battle River. ND <0.0005 mg/kg

Species	Tissue	Sample Size	Fish Weight (kg) Range (Average)	HCB	α-BHC	DDE	DDD	Heptachlor epoxide	Dieldrin	Oxychlordane	Chlordane	PCB
LAKE NEWELL												
Lake Whitefish	Muscle	4	0.50-1.50 (1.10)	ND	ND-0.001	ND-0.003	ND	ND	ND	ND	ND	ND
	Fat	19	0.50-1.50 (0.94)	0.001-0.028	0.011-0.094	0.046-0.132	ND	ND-0.010	ND-0.001	ND	0.005-0.050	ND-0.94
McGREGOR LAKE												
Lake Whitefish	Muscle	4	1.03-2.36 (1.61)	ND-0.001	0.002-0.009	0.001-0.002	0.001-0.002	ND-0.001	ND-0.001	ND	ND-0.001	ND
	Fat	14	0.82-2.36 (1.32)	ND-0.034	0.010-0.151	0.036-0.[illegible]	ND-0.022	0.008-0.022	0.006-0.025	ND	0.003-0.060	ND-0.75
Northern Pike	Muscle	4	1.28-3.38 (2.56)	ND	ND-0.001	ND-0.004	ND-0.001	ND	ND	ND-0.001	ND-0.001	ND-0.04
	Fat	7	0.85-3.38 (2.33)	0.010-0.027	0.091-0.148	0.070-0.342	0.009-0.044	0.008-0.021	0.012-0.036	ND	0.048-0.226	ND-3.78
BATTLE RIVER												
Northern Pike	Muscle	28	0.16-1.14 (0.36)	ND	ND-0.001	ND	ND	ND	ND	ND	ND	ND-0.02
	Fat	28	0.16-1.14 (0.36)	ND-0.015	0.033-0.084	ND-0.067	ND	ND-0.004	ND	ND	ND-0.029	ND-4.62
White Sucker	Muscle	20	0.49-1.80 (1.00)	ND	ND-0.011	ND-0.001	ND	ND	ND	ND	ND	ND-0.20
	Fat	15	0.49-1.80 (1.08)	0.002-0.009	0.018-0.090	0.005-0.024	ND	ND	ND-0.010	ND	ND-0.012	ND-4.99

4.4 Battle River

Only two compounds (∝-BHC,PCB), were found in the muscle of northern pike (Table 4, Appendix IV). PCB was the more common of the two, reaching 0.02 mg/kg, compared to 0.001 mg/kg for ∝-BHC. Both compounds were also found in white suckers, albeit at slightly higher concentrations (0.011 and 0.20 mg/kg respectively).

Fat samples from both species contained detectable levels of hexachlorobenzene, ∝-BHC, DDE, dieldrin, chlordane/oxychlordane and PCB's. Of these, PCB's occurred in the greatest concentration (4.6-5.0 mg/kg), followed by ∝-BHC (0.084-0.090 mg/kg) and DDE (0.024-0.067 mg/kg).

4.5 Beaver River

Four species of fish (northern pike, walleye, longnose sucker, white sucker) were collected from this river. Six compounds were detected in the samples, the most common of which were DDE and PCB's (Table 5, Appendix V). Although the concentration of these compounds was relatively low, with peak values ranging up to 0.036-0.038 mg/kg, substantially greater residues were found in the fat samples. One specimen contained DDE, DDD and PCB levels of 10.1, 10.3 and 74.1 mg/kg respectively.

Table 5. Range in concentration (mg/kg wet weight) of pesticides and PCB's in fish from the Beaver River. ND <0.0005 mg/kg

Species	Sample Size	Fish Weight (kg) Range (Average)	HCB	α-BHC	DDE	DDD	DDT	Dieldrin	Chlordane	PCB's
MUSCLE										
Northern Pike	8	0.33-1.07 (0.74)	ND	ND-0.001	ND-0.038	ND	ND-0.030	ND	ND	ND-0.21
Walleye	21	0.19-1.47 (0.66)	ND	ND-0.001	ND-0.019	ND-0.004	ND-0.007	ND	ND-0.001	ND-0.036
Longnose Sucker	4	0.35-0.84 (0.51)	ND	ND-0.001	ND-0.001	ND	ND	ND	ND	ND
White Sucker	16	0.38-1.01 (0.86)	ND	ND-0.002	ND-0.003	ND	ND	ND	ND	ND
FAT										
Northern Pike	5	0.58-1.07 (0.86)	ND-0.004	ND-0.123	ND-10.05	ND-10.27	ND	ND	ND	ND-74.1
Walleye	19	0.19-1.47 (0.69)	0.001-0.015	0.008-0.072	0.008-1.93	0.016-0.267	ND-0.73	ND-0.016	ND-0.262	0.13-4.60
Longnose Sucker	2	0.48-0.84 (0.66)	0.006	0.032	0.033	ND	ND	ND	ND	ND
White Sucker	13	0.38-1.01 (0.82)	0.004-0.006	0.004-0.028	0.010-0.130	ND-0.052	ND	ND	ND-0.008	ND-0.63

5. DISCUSSION

One of the main points of this study is that the concentrations of pesticides and PCB's in fish from all five systems were low, and well below safe consumption standards. In addition, since there is currently little or no commercial production of the compounds that were detected, residues will probably decrease in future years. As indicated earlier, the relatively high levels found in the intestinal fat of some specimens is due to the lipophilic nature of many chlorinated compounds. Since the intestinal fat of fish is not normally eaten, these levels should not constitute a threat to human consumers.

Residues in fish from the five systems are much lower than those recorded for the heavily industrialized parts of North America. In the lower Great Lakes PCB concentrations ranged up to 2-5 mg/kg in the muscle tissue of some species compared with the maximum of 0.2 mg/kg recorded in this study (Table 6). Similarly, DDE/DDT residues varied from <0.01 to >1.00 in fish from the Great Lakes whereas the corresponding range found in this study was <0.0005 to 0.038 mg/kg. Although lindane is still used extensively in Alberta and the rest of Canada, it is seldom found in fish tissues. This is due to its abbreviated half-life in tissues (2-10 days) compared to that of PCB's (55-110 days), chlordane (20-40 days) and other chlorinated pesticides. In addition, the concentration factor for lindane (~150) is much lower than that observed for PCB's and chlorinated pesticides (10^4-10^6). This is one of the reasons why lindane continues to be used in Canada whereas the production/use of other chlorinated pesticides has been either limited or restricted. The non-detectable concentrations of

organo-phosphate pesticides and phenoxy pesticides recorded in this study also reflect their short half-life and low concentration factor in tissues.

Based on the low residues recorded in this study, there is no need to conduct routine analysis of tissues in the five water systems. However, additional analysis should be performed in ~5 years time, to ensure that levels have remained low. It is recommended that such a study be initially restricted to a relatively small number of fish (5-10 per species). In the event of significant adulteration, additional specimens should be collected.

Table 6. Average concentration (mg/kg wet weight) of pesticides and PCB's in muscle tissue of some fish from the Great Lakes

Species	DDE	DDT	PCB	Dieldrin	Chlordane
LAKE ST. CLAIR					
Walleye	<0.01-0.21	<0.01-0.04	<0.1-2.0	<0.01-0.15	<0.001-0.028
White Sucker	<0.01-0.12	<0.01-0.14	<0.1-0.4	<0.01	0.004-0.011
Yellow Perch	<0.01-0.16	0.04-0.23	<0.1-0.2	<0.01	0.005-0.008
LAKE ERIE					
Walleye	<0.01-0.13	<0.01-0.01	<0.1-0.8	<0.01-0.03	---
Yellow Perch	0.05-0.99	0.05-0.66	0.3-5.1	0.03-0.45	<0.001-0.020
Rainbow Trout	0.02-0.43	<0.01	<0.01-0.8	<0.01-0.26	---
LAKE HURON					
Walleye	0.16-1.01	0.03-1.01	0.3-2.5	0.01-0.13	<0.01-0.19
Lake Whitefish	0.03-1.58	0.01-0.31	0.1-0.5	0.03-0.14	0.03-0.09
White Sucker	<0.01-0.20	<0.01-0.14	<0.1-0.2	<0.01	<0.001-0.013
Yellow Perch	0.06-0.68	0.01-0.55	<0.1-0.4	<0.01-0.05	<0.001-0.013

Sources: Frank et al (1978 a,b)

REFERENCES

Frank, R., M. Holdrinet, H.E. Braun, D.P. Dodge, and G.E. Sprangler. 1978[a]. Residues of organochlorine insecticides and polychlorinated biphenyls in fish from Lake Huron and Superior, Canada -- 1968-76. Pesticides Monitoring Journal 12:60-68.

Frank, R., H.E. Braun, M. Holdrinet, D.P. Dodge, and S.J. Nepszy. 1978[b]. Residues of organochlorine insecticides and polychlorinated biphenyls in fish from Lakes Saint Clair and Erie, Canada -- 1968-76. Pesticides Monitoring Journal 12:69-80.

Gunther, F.A. 1970. Pesticide residues in the total environment: reliable detection and determination, mitigation, and legislative control and surveillance programmes. Pure and Applied Chemistry, 21, 355-

SITE LEGEND
1: 2 km east of Fallis Point

APPENDIX I
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Wabamun Lake

SPECIES: White Sucker

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		αBHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	27/08/82	42.2	1.18	F	4+	-	0.004	0.003	0.051	-	-	-	0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	41.2	1.60	F	3+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	41.8	1.20	F	4+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	42.6	1.15	M	5+	-	[0.012*]	0.001	[0.071*]	-	-	0.001	[0.027*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	38.8	0.87	M	4+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	36.1	0.67	M	4+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	39.7	1.10	F	3+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	45.3	1.30	M	5+	0.001	[0.008*]	0.007	[0.068*]	-	-	0.002	[0.018*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	42.5	1.22	F	4+	-	0.019	0.005	0.142	-	-	-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-
1	27/08/82	42.3	1.18	M	4+	-		0.005		-	-	0.001		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	39.2	1.05	M	4+	-	[0.011*]	0.004	[0.121*]	-	-	0.002	[0.052*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	41.5	1.15	F	4+	-		0.003		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	40.8	1.18	F	3+	-	[0.008*]	0.001	[0.073*]	-	-	-	[0.011*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	41.1	1.12	M	4+	-		0.002		-		0.001		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	36.2	0.81	M	3+	-		0.002		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	40.5	1.08	F	4+	-		0.001		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/08/82	44.3	1.21	M	4+	-		0.004		-		-		-	-	-	-	-	-	-	-	-	-	-	-	0.01	

*] samples combined

SITE LEGEND
1: 2 km east of Fallis Point

APPENDIX I
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Wabamun Lake

SPECIES: Lake Whitefish

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		αBHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	27/05/81	42.0	0.93	M	8+	-	[	0.001	[	-	-	-	[	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	42.3	0.90	F	6+	-	0.005*]	0.001	0.043*]	-	-	0.001	0.039*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	46.3	0.94	M	7+	-	[	0.001	[	-	-	0.002	[	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	37.5	0.70	M	5+	-	0.009*]	0.001	0.030*]	-	-	0.001	0.032*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	41.9	0.92	M	8+	0.001	0.003	0.006	0.031	-	-	0.006	0.030	-	-	0.003	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	43.3	0.84	M	8+	-	[	-	[	-	-	0.001	[	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-
1	27/05/81	32.0	0.44	F	4+	-	0.007*]	0.001	0.052*]	-	-	-	0.030*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/05/81	31.8	0.42	M	4+	-		0.001		-		0.001		-		-		-		-		-		-		0.007	
1	27/05/81	32.6	0.42	M	5+	-		0.001		-		0.001		-		-		-		-		-		-		-	
1	27/05/81	39.6	0.65	M	4+	-		-		-		-		-		-		-		-		-		-		-	
1	27/05/81	39.6	0.84	F	4+	-		0.002		-		-		-		-		-		-		-		-		-	
1	27/05/81	35.3	0.52	M	5+	-		-		-		-		-		-		-		-		-		-		-	
1	27/06/81	31.1	0.38	M	4+	-		0.001		-		-		-		-		-		-		-		-		-	

*] samples combined

SITE LEGEND
1: 2 km east of Fallis Point

APPENDIX I
Pesticide and PCB Residue Analysis
All results in ng/kg (ppm)

RIVER/LAKE: Wabamun Lake

SPECIES: Northern Pike

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		α-BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	27/06/81	47.4	0.78	F	3+	-	-	-	-	-	-	-	0.021	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	41.8	0.55	M	2+	-	-	-	-	-	-	-	0.058	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	37.0	0.38	M	2+	-	[	0.001	[	-	-	-	[	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
1	27/06/81	37.5	0.42	M	1+	-	0.008*]	0.001	0.044*]	-	-	-	0.135*]	-	-	-	-	-	-	-	-	-	-	-	-	-	[
1	27/06/81	37.3	0.40	F	2+	-	0.007	0.001	0.070	-	-	-	0.089	-	-	-	-	-	-	-	-	-	-	-	-	-	0.45*]
1	27/06/81	38.7	0.42	M	2+	-	0.013	-	0.069	-	-	-	0.105	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
1	27/06/81	34.5	0.31	F	1+	-	[	-	[	-	-	-	[	-	-	-	-	-	-	-	-	-	-	-	-	-	0.43
1	27/06/81	51.6	0.98	M	3+		0.008*]		0.057*]		-		0.074*]	-	-	-	-	-	-	-	-	-	-	-	-	-	[
1	27/06/81	42.1	0.54	M	2+	-	0.009	-	0.068	-	-	-	0.098	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10*]
1	27/06/81	40.5	0.80	F	2+	-	-	-	0.014	-	-	-	0.105	-	-	-	-	-	-	-	-	-	-	-	-	-	0.31
1	27/06/81	38.0	0.45	F	1+	-	-	-	0.012	-	-	-	0.104	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
1	27/06/81	45.9	0.75	M	2+	-	-	0.001	0.010	-	-	-	0.120	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18
1	27/06/81	40.9	0.84	M	3+	-	0.025	0.003	0.174	-	-	0.001	0.123	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
1	27/06/81	61.8	1.98	F	8+	0.001	0.014	0.003	0.059	-	-	0.007	0.243	-	-	0.001	-	-	-	-	-	-	-	-	0.032	-	0.48
1	27/06/81	49.3	0.74	F	3+	-	-	-	[	-	-	-	[	-	-	-	-	-	-	-	-	-	-	0.001	0.034	0.03	1.07
1	27/06/81	48.4	0.85	M	3+	-	-	-	0.008*]	-	-	-	0.015*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	67.2	2.48	F	4+	-	-	0.001	0.014	-	-	0.002	0.018	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	41.4	0.56	F	2+	-	0.016	0.001	0.149	-	-	0.001	0.100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	56.8	1.46	F	3+	-	0.021	-	0.173	-	-	-	0.146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	27/06/81	59.9	1.64	F	5+	-	-	0.001	0.008	-	-	0.001	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*] samples combined

SITE LEGEND
#1: 1 km south of Kinbrook Island Provincial Park

APPENDIX II
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Lake Newell

SPECIES: Lake Whitefish

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		∝BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	23/11/81	37.3	0.78	M	4+	-	[0.015*]	[0.001]	[0.013*]	-	-	[0.001*]	[0.089*]	-	-	-	-	-	[0.004*]	-	-	-	-	-	[0.020*]	-	-
1	23/11/81	41.8	1.50	M	9+						-				-		-				-		-				
1	23/11/81	41.6	1.50	M	8+		[0.006*]		[0.042*]		-		[0.081*]		-		-		-		-		-		[0.014*]		-
1	23/11/81	38.4	0.90	M	7+						-				-		-				-		-				-
1	23/11/81	38.1	0.80	M	8+		[0.008*]		[0.051*]		-		[0.086*]		-		-		[0.002*]		-		-				-
1	23/11/81	40.5	0.99	M	12+						-				-		-				-		-				-
1	23/11/81	32.0	0.50	M	3+	-	0.009	0.001	0.093	-	-	-	0.065	-	-	-	-	-	0.007	-	0.007	-	-	-	0.027	-	-
1	23/11/81	40.1	0.97	M	8+		[0.028*]	[0.001]	[0.074*]	-	-	[0.003*]	[0.140*]	-	-	-	-	-	-	-	-	-	-	-	[0.050*]	-	[0.94]
1	23/11/81	39.7	0.98	M	8+	-																					
1	23/11/81	36.6	0.72	M	6+																						
1	23/11/81	35.2	0.69	F	5+		[0.005*]		[0.029*]		-		[0.094*]		-		-		-		-		-		[0.019*]		-
1	23/11/81	37.9	0.80	F	8+						-				-		-				-		-				-
1	23/11/81	40.5	0.90	M	9+						-				-		-				-		-				-
1	23/11/81	42.1	1.03	M	10+		[0.007*]		[0.037*]		-		[0.073*]		-		-		-		-		-		[0.018*]		-
1	23/11/81	41.9	1.20	F	8+						-				-		-				-		-				-
1	23/11/81	37.0	0.70	M	6+		[0.001*]		[0.011*]		-		[0.046*]		-		-		-		-		-		[0.005*]		-
1	23/11/81	37.6	0.78	M	7+						-				-		-				-		-				-
1	23/11/81	37.0	0.63	M	6+						-				-		-				-		-				-
1	23/11/81	40.5	1.45	M	10+	-	0.019	0.001	0.094	-	-	-	0.132	-	-	-	-	-	0.010	-	-	-	-	-	0.030	-	-

*] samples combined

APPENDIX III
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

SITE LEGEND
#1:West shore, 6km north of Hwy 531

RIVER/LAKE: McGregor Lake

SPECIES: Lake Whitefish

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		<BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	20/11/81	45.2	1.53	F	5+		0.026		0.133		-		0.054		-		0.009		0.016		0.025		-		0.042		-
1	20/11/81	39.2	1.02	M	5+		0.021		0.151		-		0.061		-		0.010		0.014		0.016		-		0.051		0.54
1	20/11/81	56.1	2.36	F	10+	0.001	0.034	0.009	0.141	-	-	0.002	0.115	-	-	0.001	0.018	0.001	0.022	0.001	0.018	-	-	0.001	0.050	-	-
1	20/11/81	41.9	1.09	F	6+		-		-		-		-				-		-		-		-		-		-
1	20/11/81	41.9	1.20	F	4+		-		-		-		-		-		-		-		-		-		-		-
1	20/11/81	39.8	1.15	F	5+		0.003		0.015		-		0.015		-		-		-		-		-		0.003		-
1	20/11/81	40.7	1.08	M	4+	-	0.022	0.004	0.103	-	-	0.002	0.084	-	-	0.002	0.022	0.001	0.013	0.001	0.010	-	-	0.001	0.060	-	0.75
1	20/11/81	51.5	1.98	M	6+	0.001	0.032	0.003	0.133	-	-	0.001	0.040	-	-	-	-	0.001	0.019	-	0.010	-	-	0.001	0.024	-	-
1	20/11/81	44.1	1.42	F	6+		-		-		-		-		-		-		-		-		-		-		-
1	20/11/81	41.2	1.28	F	6+		-		-		-		-		-		-		-		-		-		-		-
1	20/11/81	44.3	1.50	F	5+		-		0.010		-		-		-		-		-		-		-		-		-
1	20/11/81	38.0	0.82	M	4+		0.013		0.070		-		0.040		-		-		0.008		0.006		-		0.026		-
1	20/11/81	41.7	1.07	F	4+		0.020		0.134		-		0.036		-		-		0.015		0.009		-		0.023		-
1	20/11/81	40.4	1.03	F	5+	-		0.002		-		0.001		-		-		-		-		-		-			

*] samples combined

SITE LEGEND
#1:West shore, 6 km north of Hwy 531

APPENDIX III
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: McGregor Lake

SPECIES: Northern Pike

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		α-BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	20/11/81	74.0	3.38	M	7+	-	0.027	-	0.146	-	-	-	0.167	-	-	-	0.032	-	0.021	-	0.026	-	-	-	0.093	-	1.64
1	20/11/81	66.7	2.39	M	5+	-	0.026	0.001	0.141	-	-	0.004	0.342	-	-	0.001	0.044	-	0.018	-	0.036	0.001	-	0.001	0.226	0.04	3.78
1	20/11/81	47.3	0.85	F	2+		0.010		0.091		-		0.070		-		-		0.008		0.012		-		0.048		-
1	20/11/81	55.5	1.28	F	4+	-	0.016	-	0.148	-	-	-	0.277	-	-	-	0.041	-	0.014	-	0.024	-	-	-	0.142	-	1.37
1	20/11/81	70.8	2.82	F	5+		0.019		0.133		-		0.075		-		0.015		0.019		0.023		-		0.059		-
1	20/11/81	61.8	2.37	F	4+		0.025		0.144		-		0.083		-		0.022		0.016		0.018		-		0.069		0.58
1	20/11/81	68.9	3.21	F	4+	-	0.020	-	0.106	-	-	-	0.075	-	-	-	0.009	-	0.016	-	0.018	-	-	-	0.064	-	-

SITE LEGEND
1: POWER PLANT RESERVOIR

APPENDIX IV
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Battle River

SPECIES: White Sucker

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		<BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	07/07/81	38.3	0.89	F	3+	-	0.009	0.001	0.060	-	-	-	0.006	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	07/07/81	43.2	1.10	F	5+	-	0.009	0.003	0.090	-	-	0.001	0.008	-	-	-	-	-	-	-	0.005	-	-	-	-	-	-
1	07/07/81	39.2	0.95	M	4+	-	0.004	-	0.062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	07/07/81	40.3	1.00	M	3+	-	0.002	0.003	0.045	-	-	-	0.011	-	-	-	-	-	-	-	0.009	-	-	-	-	0.01	-
1	07/07/81	41.4	0.91	M	7+	-	0.009	0.002	0.067	-	-	-	0.017	-	-	-	-	-	-	-	0.010	-	-	-	-	0.01	0.36
1	07/07/81	47.5	1.50	F	5+	-	0.005	0.011	0.080	-	-	-	0.010	-	-	-	-	-	-	-	0.003	-	-	-	-	0.04	0.50
1	07/07/81	41.0	0.94	M	4+	-	0.003	0.001	0.018	-	-	-	0.006	-	-	-	-	-	-	-	-	-	-	-	-	0.04	1.75
1	07/07/81	42.0	1.12	M	6+	-	0.005	0.001	0.054	-	-	-	0.024	-	-	-	-	-	-	-	-	-	-	-	0.012	-	0.29
1	07/07/81	32.7	0.49	F	2+	-	0.002	0.001	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	07/07/81	46.4	1.45	F	7+	-	0.008	0.002	0.060	-	-	0.001	0.012	-	-	-	-	-	-	-	-	-	-	-	-	-	0.33
1	07/07/81		0.91	M	4+	-	0.007	0.001	0.048	-	-	-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28
1	07/07/81	40.2	0.93	M	5+		0.004		0.024	-			0.019		-		-				-		-		0.009		0.54
1	07/07/81	40.9	1.10	F	5+	-	0.004	0.002	0.034	-	-	-	0.005	-	-	-	-	-	-	-	-	-	-	-	-	-	0.26
1	07/07/81	41.6	1.80	M	2+	-	0.008	0.004	0.069	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	4.99
1	07/07/81	41.6	1.05	F	4+	-	0.008	0.001	0.068	-	-	-	0.006	-	-	-	-	-	-	-	-	-	-	-	0.003	-	0.34
1	07/07/81	35.2	0.67		2+	-		0.001		-		-		-		-		-		-		-		-		-	
1	07/07/81	37.3	0.80	M	4+	-		0.002		-		-		-		-		-		-		-		-		-	
1	07/07/81	34.1	0.61		3+	-		0.001		-		-		-		-		-		-		-		-		-	
1	07/07/81	35.3	0.68	M	3+	-		0.001		-		-		-		-		-		-		-		-		-	
1	07/07/81	42.2	1.10	M	6+	-		0.001		-		-		-		-		-		-		-		-		-	

APPENDIX IV
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

SITE LEGEND
1: POWER PLANT RESERVOIR

RIVER/LAKE: Battle River

SPECIES: Northern Pike

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		-BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	07/07/81	56.9	1.14	F	4+	-	0.006	-	0.037	-	-	-	0.025	-	-	-	-	-	-	-	-	-	-	-	0.029	0.01	3.59
1	07/07/81	47.8	0.82	F	3+	-	0.015	-	0.064	-	-	-	0.033	-	-	-	-	-	0.004	-	-	-	-	-	0.028	-	2.92
1	07/07/81	50.5	0.93	F	4+	-	0.008	-	0.062	-	-	-	0.064	-	-	-	-	-	0.003	-	-	-	-	-	0.015	-	1.25
1	07/07/81	33.6	0.26	F	2+	-	0.005	-	0.051	-	-	-	0.067	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63
1	07/07/81	34.0	0.30	F	2+	-	0.007	-	0.060	-	-	-	0.014	-	-	-	-	-	-	-	-	-	-	-	0.007	-	-
1	07/07/81	32.7	0.24	M	1+	-	0.005	-	0.038	-	-	-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-	0.84
1	07/07/81	28.8	0.19	M	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	28.5	0.17	M	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	28.8	0.16	F	1+	-	0.004*	-	0.041*	-	-	-	0.017*	-	-	-	-	-	-	-	-	-	-	-	-	-	0.91 *
1	07/07/81	30.2	0.20	F	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	35.2	0.34	F	2+	-	-	-	0.084	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.67
1	07/07/81	29.8	0.17	F	1+	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	29.1	0.20	M	1+	-	0.007*	-	0.074*	-	-	-	- *	-	-	-	-	-	-	-	-	-	-	-	-	-	0.92 *
1	07/07/81	31.5	0.19	M	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	32.0	0.22	F	1+	-	-	-	0.073	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	07/07/81	27.3	0.16	F	1+	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	07/07/81	28.3	0.18	M	1+	-	0.006*	-	0.079*	-	-	-	- *	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00 *
1	23/07/81	29.8	0.18	F	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	23/07/81	29.1	0.17	F	1+	-	0.003*	-	0.049*	-	-	-	0.020*	-	-	-	-	-	-	-	-	-	-	-	-	-	1.13 *
1	23/07/81	30.8	0.19	M	1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	23/07/81	30.1	0.19	F	1+	-	0.003*	-	0.041*	-	-	-	0.008*	-	-	-	-	-	-	-	-	-	-	-	-	-	1.54 *
1	23/07/81	47.3	0.70	M	3+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	0.02	
1	23/07/81	49.7	0.84	F	4+	-	0.014*	-	0.090*	-	-	-	0.040*	-	-	-	-	-	-	-	-	-	-	-	-	0.01	3.98 *
1	23/07/81	41.3	0.44	M	3+	-	0.004	-	0.033	-	-	-	0.043	-	-	-	-	-	-	-	-	-	-	-	-	0.01	3.62
1	23/07/81	33.0	0.23	F	2+	-		0.001		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	23/07/81	37.7	0.33	M	3+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
1	23/07/81	29.3	0.18	F	1+	-	0.001*	-	0.043*	-	-	-	0.009*	-	-	-	-	-	-	-	-	-	-	-	-	-	1.07 *
1	23/07/81	27.3	0.60		1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	

*] samples combined

SITE LEGEND
1: LA COREY BRIDGE

APPENDIX V
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Beaver River

SPECIES: Walleye

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		α-BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	08/10/81	47.3	1.47	M	13+	-	0.014	0.001	0.070	-	-	0.019	1.93	0.007	0.73	-	0.016	-	-	-	-	-	-	-	0.064	-	2.19
1	08/10/81	47.5	1.08	F	6+	-	0.011	0.001	0.064	-	-	0.007	0.594	-	-	0.004	0.267	-	-	-	-	-	-	0.001	0.044	0.03	4.60
1	08/10/81	40.1	0.88	F	-	-	0.011	-	0.070	-	-	-	0.040	-	-	-	-	-	-	-	-	-	-	-	0.008	-	0.32
1	08/10/81	27.0	0.20	F	1+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	42.0	0.75	M	5+	-	0.014	0.001	0.066	-	-	0.001	0.156	-	-	-	-	-	-	-	-	-	-	-	0.018	0.01	2.38
1	08/10/81	43.4	0.96	M	6+	-	0.012	0.001	0.055	-	-	0.001	0.075	-	-	-	-	-	-	-	-	-	-	-	0.009	-	0.22
1	08/10/81	39.1	0.73	F	3+	-	0.008	-	0.059	-	-	-	0.056	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21
1	08/10/81	38.5	0.71	M	9+	-	0.011	-	0.062	-	-	0.001	0.182	-	-	-	-	-	-	-	-	-	-	-	-	-	0.81
1	08/10/81	43.4	0.92	F	5+	-	0.010	-	0.059	-	-	-	0.067	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
1	08/10/81	36.3	0.60	M	4+	-	0.008	0.001	0.040	-	-	0.006	0.945	-	-	0.003	0.464	-	-	-	-	-	-	-	0.050	0.01	2.87
1	08/10/81	39.2	0.68	F	4+	-	0.011	0.001	0.053	-	-	0.003	0.414	-	-	0.002	0.127	-	-	-	-	-	-	-	0.036	0.007	1.92
1	08/10/81	41.3	0.91	M	7+	-	0.015	0.001	0.068	-	-	0.001	0.069	-	-	-	-	-	-	-	-	-	-	-	0.009	-	0.13
1	08/10/81	45.0	1.15	M	11+	-	0.012	-	0.072	-	-	0.003	0.747	-	0.04	-	0.193	-	-	-	0.016	-	-	-	0.262	-	2.44
1	08/10/81	40.4	0.88	M	8+	-	0.009	-	0.051	-	-	-	0.078	-	-	-	0.022	-	-	-	-	-	-	-	0.004	-	-
1	08/10/81	39.4	0.70	M	4+	-	0.010	-	0.054	-	-	0.002	0.409	-	-	-	0.200	-	-	-	-	-	-	-	0.024	-	1.21
1	08/10/81	27.6	0.23	F	1+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	26.1	0.20		1+		0.001*		0.008*				0.015*														
1	08/10/81	27.4	0.22		1+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	25.2	0.19		1+	-	0.001*	-	0.028*	-	-	-	0.008*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	27.4	0.22	M	1+	-		0.001		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	28.2	0.24		1+	-		-		-		0.001		-		-		-		-		-		-		-	

*] samples combined

SITE LEGEND
1: LA COREY BRIDGE

APPENDIX V
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Beaver River

SPECIES: White Sucker

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		α-BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	08/10/81	40.1	0.98	F	3+	-	[	0.001	[	-	-	0.003	[	-	-	-	[	-	-	-	-	-	-	-	[	-	[
1	08/10/81	39.6	0.96	M	5+	0.006*	0.001	0.021*		-	-	-	0.130*	-	-	-	0.052*	-	-	-	-	-	-	-	0.008*	-	0.63
1	08/10/81	38.4	0.82	F	3+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	37.8	0.78	M	2+	-		-	0.004*	-	-	0.001	0.020*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	38.9	0.90	F	4+	-		-		-		0.001		-		-		-		-	-	-	-	-	-	-	-
1	08/10/81	40.4	0.85	F	3+	-	0.006	-	0.028	-	-	-	0.022	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	40.5	0.90	F	4+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	40.3	0.88	M	4+	-	0.004*	0.001	0.012*	-	-	0.003	0.057*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	40.8	1.00	F	4+	-	0.004	0.001	0.017	-	-	-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	29.3	0.38		1+	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	41.3	1.01	F	4+	-	0.005*	0.001	0.025*	-	-	-	0.021*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	36.2	0.65	M	3+	-		0.001		-		-		-		-		-		-		-		-		-	
1	08/10/81	36.3	0.71	M	4+	-		-		-		0.001		-		-		-		-		-		-		-	
1	08/10/81	38.3	0.89	M	4+	-		0.001		-		0.001		-		-		-		-		-		-		-	
1	08/10/81	40.6	1.00	F	4+	-		0.001		-		0.001		-		-		-		-		-		-		-	
1	08/10/81	40.1	0.98	M	4+	-		0.001		-		0.001		-		-		-		-		-		-		-	

*] samples combined

SITE LEGEND
1: LA COREY BRIDGE

APPENDIX V
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Beaver River

SPECIES: Longnose Sucker

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		∝BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	08/10/81	39.3	0.84	F	5+	-	[0.006*]	0.001	[0.032*]	-	-	-	[0.033*]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	32.6	0.48	M	4+	-		-		-	-	0.001		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	30.1	0.38		3+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	29.5	0.35		4+	-		-		-		-		-		-		-		-		-		-		-	

SITE LEGEND
1 LA COREY BRIDGE

APPENDIX V
Pesticide and PCB Residue Analysis
All results in mg/kg (ppm)

RIVER/LAKE: Beaver River

SPECIES: Northern Pike

- is less than 0.0005 mg/kg (ppm)

Blank - no data

SITE	DATE	FK LG (cm)	WT (kg)	SEX	AGE	HCB		∝BHC		LINDANE		DDE		DDT		DDD		HEPTACHLOR EPOXIDE		DIELDRIN		OXYCHLORDANE		CHLORDANE		PCB	
						muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat	muscle	fat
1	08/10/81	49.2	0.75	M	4+	-	0.002	-	-	-	-	-	0.003	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	46.9	0.63	F	3+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	35.6	0.33	M	2+	-		-		-		-		-		-		-		-		-		-		-	
1	08/10/81	54.4	1.07	M	6+	-	0.004	0.001	0.123	-	-	-	0.083	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	50.1	0.94	F	4+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	08/10/81	52.6	1.00	F	4+	-	-	-	-	-	-	0.002	0.035	-	-	-	0.004	-	-	-	-	-	-	-	-	-	-
1	08/10/81	44.9	0.60	F	3+	-		-		-		0.001		-		-		-		-		-		-		-	
1	08/10/81	43.7	0.58	M	3+	-	0.013	-	0.024	-	-	0.038	10.05	-	-	0.030	10.27	-	-	-	-	-	-	-	-	0.21	74.1

POOR

QUALITY

ORIGINAL